Tribomechanical properties of DLC coatings deposited by positive ion assisted magnetron sputtering

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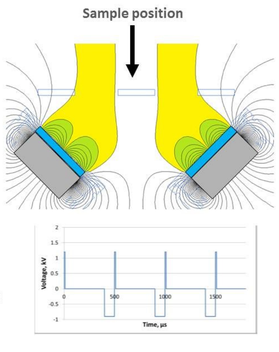
Abstract

- Diamond Like Carbon (DLC) presents a very wide spread range of properties.
- DLC coatings can be deposited without sample Bias qith high hardness. Thus, DLC coatings can be applied to insulating substrates, such as plastics or glass.
- HIPIMS ion metal etching with Ti and Cr was used succesfully to enhance DLC coating adhesion
- Ongoing temperature dependent measurements of the mechanical properties.

Positive ion assisted magnetron sputtering

Positive ion bombardment

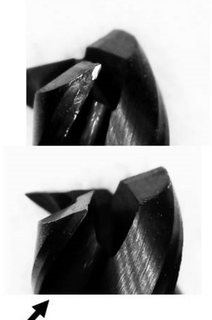


Proprietary technology: Patent application number GB1605162.5 (March 2016)

No samples Bias required!!!

Insulating substrates (plastics, glass,...)

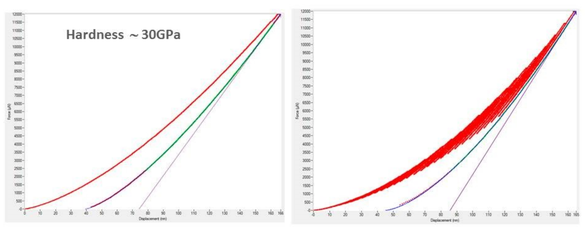
Metallic substrates with sharp edges



No flank delamination!

- In magnetron sputtering-DLC deposition Ion bombardment plays a key role on the final coating properties
- The authors have found that not only the ion bombardment but also the electron bombardment play key roles on the DLC growth. The use of magnetic and electric field and substrate location arrangements have enabled the authors to control ratio of positive ions and electron bombardment on the substrate.
- High positive Ion Bombardment and low electron bombardment produce hard low stress DLC coatings. High electron plasma interaction produce softer DLC.
- The deposition method has been successfully applied to DLC deposition of a variety of substrates such as tools, glass, plastic surfaces.

DLC properties: Nanoindentation



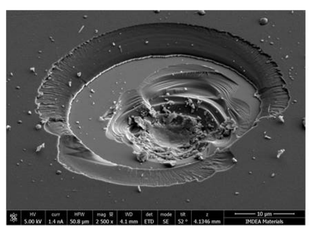
Berkovich indenter
Single indents: 2,7, 12 mN
Load-partial Unload: 12 mN
Hysitron TI950

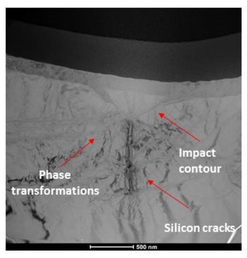
DLC properties: Friction

Family	H (GPa)	E (GPa)	µ*
a-C	30	230	0.18
a-C:H	25	190	0.14
WC-C	25	210	0.25

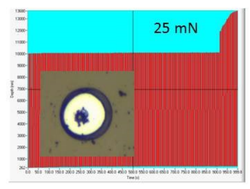
Dry conditions
ASTM G99-04

DLC on silicon: Nano-impact tests





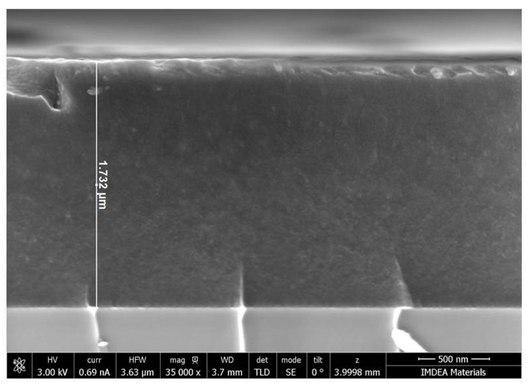
DLC on silicon



Conical indenter R= 5 µm
High-strain rate
Multiple impacts
15 min
1 impact per 4s

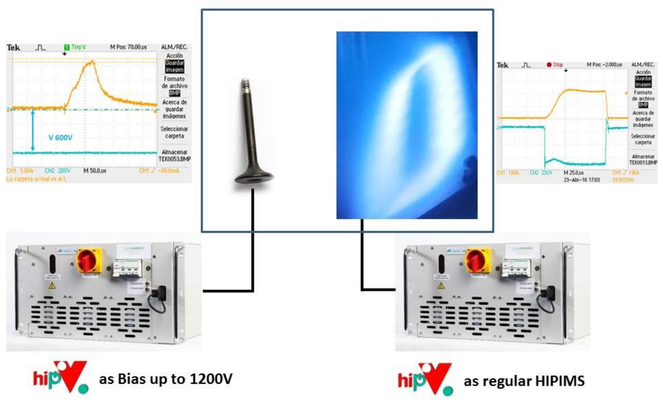
Silicon phase transformations, unaltered DLC

SEM cross section



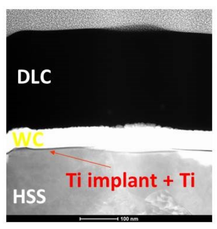
Phase transformations on the Si substrate!!

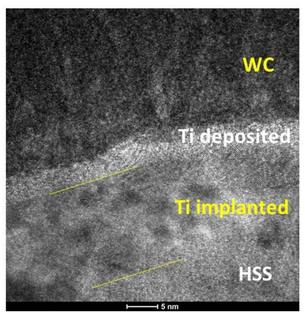
Adhesion on metal substrates: HiPIMS ion metal etch

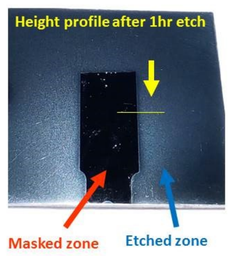


hipV as Bias up to 1200V

hipV as regular HIPIMS

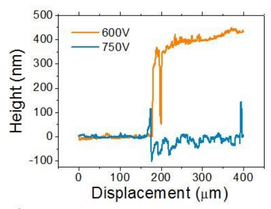




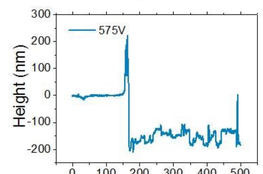


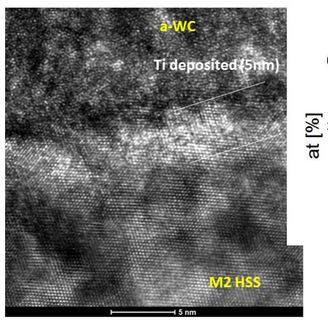
Electropolished SS304 substrate

Cr: Net deposition below 750V Bias

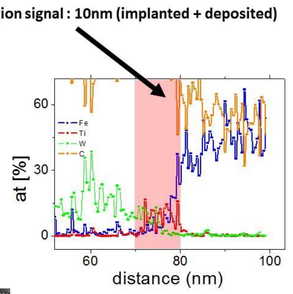


Ti: Low Bias voltage achievable!



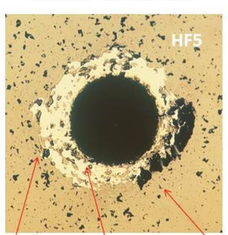


Ti region signal : 10nm (implanted + deposited)

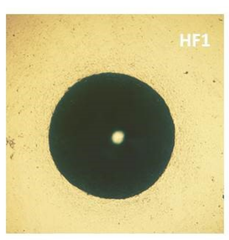


Adhesion tests: Rockwell, Nano-Scratch

WC/DLC on M2/HSS without metal ion etch

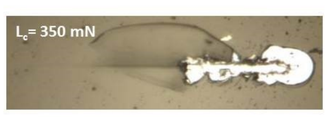


Cr metal etch + Cr/WC/DLC on HSS

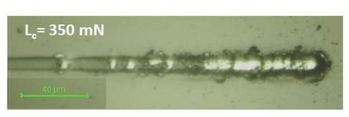


Rockwell HRC tests - 150kg - Diamond indenter conical tip

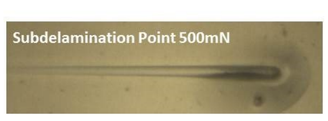
Cr/WC/DLC on Si substrate

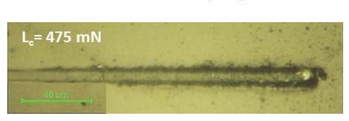


Cr/WC/DLC on M2 HSS (no metal etch)



Cr metal etch + Cr/WC/DLC on M2 HSS





Sphero-conical tip with a tip radius of 10 µm
Scratch length: 500 µm
Maximum normal load: 500 mN
Loading rate= 2.5 mN/s

Acknowledgments

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